

Epibiotic Communities of the Senatorial Scallop *Mimachlamys sanguinea* (Linnaeus, 1758) (Bivalvia: Pectinidae) from the Expansion Channel of the Suez Canal, Egypt

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ABSTRACT

This study reported the composition of the macrobenthic assemblage living on the shell of the pectinid scallop *Mimachlamys sanguinea* inhabiting the Suez Canal Expansion Channel. Nine epibiotic groups were observed encrusting the valves of the scallop primarily serpulids, barnacles and tunicates (20.9, 15.5, and 14.8%, respectively). The upper valve was significantly more fouled than the lower one. A positive correlation was observed between the percent cover of fouling material and the shell size, with maximum percent cover and size occurring during the spring. The relationship between the scallop and its fouling organisms was discussed. The importance of *M. sanguinea* shells as a natural substratum for various epibiotic groups was highlighted in this study.

INTRODUCTION

In marine ecosystems, many sessile macro-faunal species depend on suitable substrates to settle on (Soliman & Yassien, 2007; Rabaoui *et al.*, 2009). Extensive and rapid association of living and non-living surfaces takes place in a process called marine biofouling. This colonization is referred to as epibiosis when the association occurs between living organisms. Epibionts are organisms that attach themselves to a living surface, while basibionts are organisms that provide a substrate for epibionts (Wahl, 1989, 2009).

A diversity of epibiotic invertebrates and rare epiphytes is generally found encrusting the valves of molluscs all over the world (Ward & Thrope, 1991; Berkman, 1994; Burns & Bingham, 2002). In particular, several taxa can use shells of bivalves to extend their spreading abilities (Cerrano *et al.*, 2006). For example, sponges are the dominant epibiotic invertebrates encrusting the valves of scallops (Schejter & Breinec, 2007). Moreover, bivalves are good substrates to barnacles, polychaetes, hydroids, bryozoans, and algae (Cerrano *et al.*, 2006). Additionally, spat can live as epibionts on

their conspecifics such as scallop spat, which can live attached to the shell of the adult by its byssus for a duration of six to seven years (Vause *et al.*, 2005).

Many authors documented the phenomenon of epifouling in the Suez Canal (Emara & Belal, 2004; Sallam & Wicksten, 2009; Ibrahim, 2012). Ten macro-faunal species have been reported on the exoskeleton of the two spider crabs *Hyastenus hilgendorfi* (de Man, 1887) and *Schizophrys aspera* (H. Milne Edwards, 1834) inhabiting the Suez Canal, polychaetes, barnacles and tunicates being the dominant epibionts (Ibrahim, 2012).

The scallop *Mimachlamys sanguinea* (Linnaeus, 1758) (Family Pectinidae) is an Indo-Pacific species that has been reported from the Red Sea by Sharabati (1984). This bivalve is a Lessepsian migrant that was firstly recorded from the Suez Canal by Dijkstra and Knudsen (1998) and then from the Eastern Mediterranean coast by Shefer *et al.* (2012). Now, it has become an economically important species in the local markets of the canal area being present with high quantities and fairly large sizes.

The new expansion canal is an artificial channel corresponding to the existing one and is considered as a separate shipping lane serving a specific part of the main navigational channel. *M. sanguinea* was observed among the catch of the fishermen working in this area in considerable numbers and large sizes. Most shells were covered with an assortment of epibiota growing excessively and accumulating on them.

Unfortunately, no studies have been conducted to document either the fauna or their epibiotic communities on any substrate in this area. This is the first study of its kind on the epifouling of *M. sanguinea* in the expansion channel with emphasis on the relationship between the epibionts and the host.

The importance of *M. sanguinea* shells as a natural substratum for various epibiotic groups is highlighted in this study. This paper aimed to identify and quantify the structure of the associated community and its variability respect to the basibiont size percentages. Moreover, the coverage of the different taxa between the right and left valves was evaluated.

MATERIALS AND METHODS

Study area

The study area is situated in the Suez Canal expansion channel (SCEC), opposite to Ismailia City (30.441385°N 32.355423°E), which was opened for navigation in 2015 (Fig. 1). It spans a length of 72km long and a depth of 24m, designed to provide a parallel shipping lane serving a specific section in the existing 164km long canal (Suez Canal Authority, 2022). Due to the continuous dredging of the main navigational canal, as well as the passage of ships and tankers, the Suez Canal water is fairly turbid (Madkour *et al.*, 2006). The bottom of the main navigational channel consists of coarse, fine and muddy-sand with gravel and rocks (Suez Canal Authority, 2022). However, the

bottom of the expansion channel is composed of sand with few scattered rocks (personal observation).

Sampling

Scallops were monthly collected from fishermen in the channel at the area opposite to Ismailia City (Fig. 1). They were hand-picked during free diving at depths between six and nine meters, where they are found living on sandy bottoms. Specimens were collected for twelve months starting from September 2021 to August 2022. They were placed in plastic containers with sufficient seawater to cover, and transferred to the laboratory in order to keep the epibionts' natural color and form.

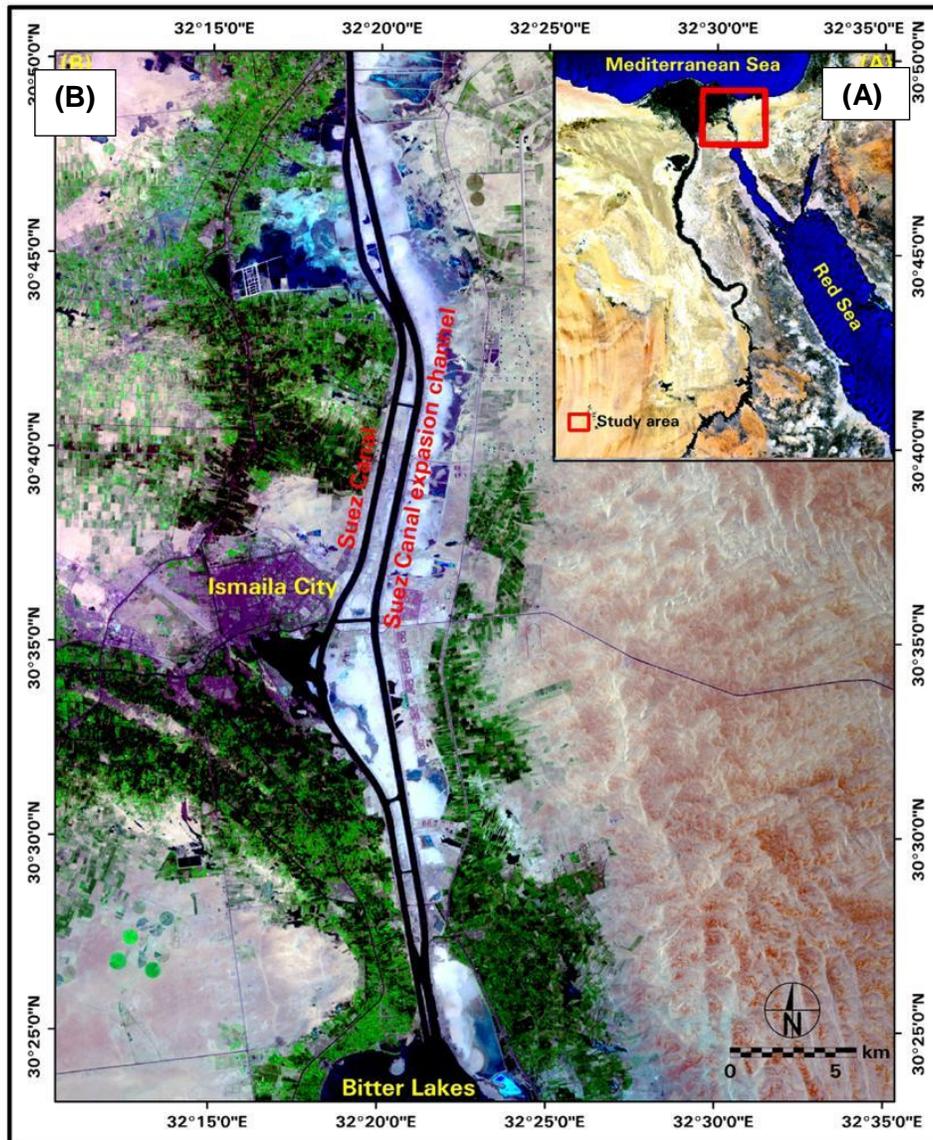


Fig. 1. (A) Location of the study area, Egypt and (B) Landsat image of the study area showing the expansion channel of the Suez Canal

Sampling

Samples were left neither washed nor cleaned to avoid any damage to the epibiota. They were examined to take notes on the color and shapes of the different epibionts. The percentage cover of epibionts established on the shells was visually estimated and expressed as percentage of the coverage (%). Each epibiont was categorized according to the following scale (25, 50, 75 and 100%).

Several trials were made to remove the epibionts from the bivalve shells by pushing a scalpel at the bottom of the covering epibionts and lifting them up. The epifauna found on each valve was identified to the lowest possible taxonomic level according to guidelines of **Por and Lerner-Seggev (1966)**, **Por (1978)**, **Millar (1970)** and **Tarjan (1980)**.

The maximum diameter of the upper (left) valve was measured (shell height) from the umbo to the ventral edge using a Vernier caliper ($\pm 0.1\text{mm}$ precision). Scallops were dissected and sexually differentiated even in the smallest size.

Statistical analysis

All statistical analyses were carried out using SPSS version 22.0 computer software. Student's *t*-test was used for the comparison between means of percentage cover of the different categories covering the shells of the two sexes (**Zar, 1984**). The McNemar test for paired proportions (**Sokal & Rohlf, 1979**) was used to establish preferences of the epibionts for any of the scallop valves.

RESULTS

A total of 451 specimens of *M. sanguinea* were collected, of which 302 (67%) were females and 149 (33%) were males. Scallop size ranged from 36.4 to 87.8mm total shell height (mean = 68.7mm and SD = ± 9.52). Scallops over 80mm shell height were recorded in the highest frequency during spring, while populations exhibited the smallest sizes in summer (Fig. 2). Ninety percent of the scallops were covered by epibionts showing overlapping organisms (Fig. 3). Epibionts were completely cemented to the bivalve shells and were impossible to remove. Twenty-two epibiont taxa belonging to nine groups of macro-epibionts were identified (Table 1).

Serpulids showed the highest percentage of coverage among epibionts (36.5% in males and 33.95% in females) followed by the two barnacle species and colonial tunicates with means of 26.11 and 24.94%, respectively. Bivalves, gastropods and sponges showed lower percentages which ranged from 5.7 to 2%, while hydrozoans, bryozoans and algae each represented only less than 1.36%. Females and males were covered by the same epibionts with more or less equal cover (Fig. 4). No significant differences were found between mean percentage cover of the different categories covering the shells of males and females (Student's *t*-test: $F = 0.003$, $df = 18$ and $P = 0.05$).

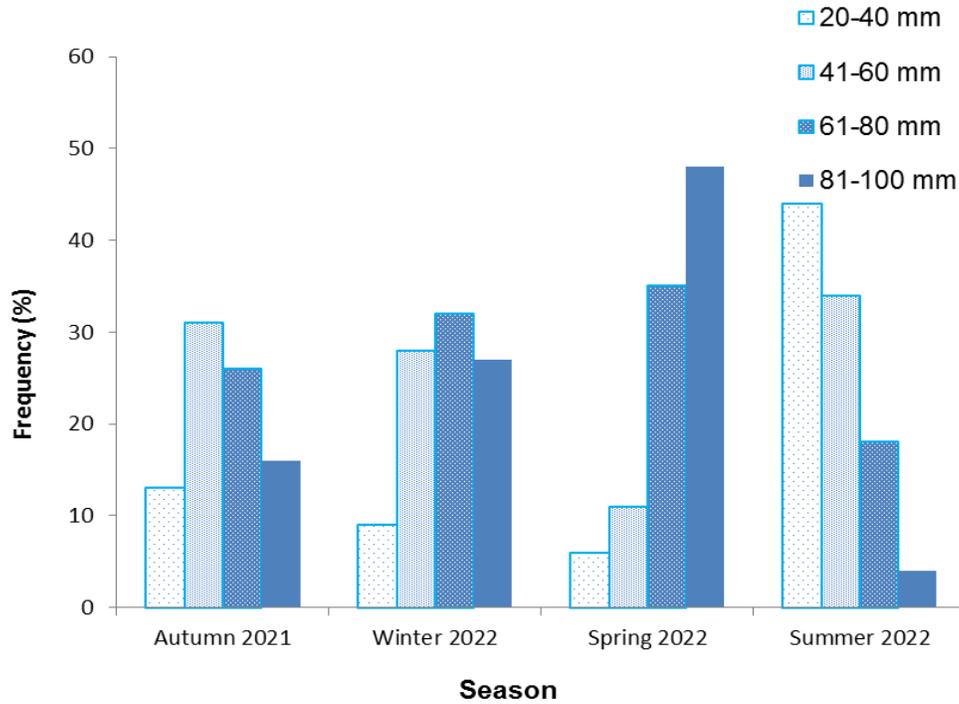


Fig. 2. Size frequency distribution of *M. sanguinea* from the Suez Canal expansion channel

There was an obvious preference for the upper (left) valve by all epibionts. Indeed, algae and sponges were completely absent from the lower (right) one. Serpulids and barnacles fouled both valves but showed a preference for the upper valve (McNemar test: left $\chi^2 = 6.72$, and $\chi^2 = 4.76$, respectively, $P = 0.05$). Bivalves and tunicates were more frequent on top of the upper valve (McNemar test: left $\chi^2 = 3.46$, and $\chi^2 = 3.88$ respectively, $P = 0.05$) (Fig. 5).

Regardless of sex, an obvious increase in the percentage cover of fouling materials was observed between the bivalve size classes (Fig. 6). Maximum cover (97%) was attained in the large sizes (> 80mm), while the minimum (23.7 %) was in shells < 40mm.

Almost half of the examined population had clean shells (i.e. epibionts with less than 25% cover) during summer. However, the highest coverage (almost 100%) was in spring (Fig. 7). The four different degrees of coverage were present throughout the seasons. On the other hand, shells with coverage more than 50% were at their highest occurrence during spring and their minimum in summer.

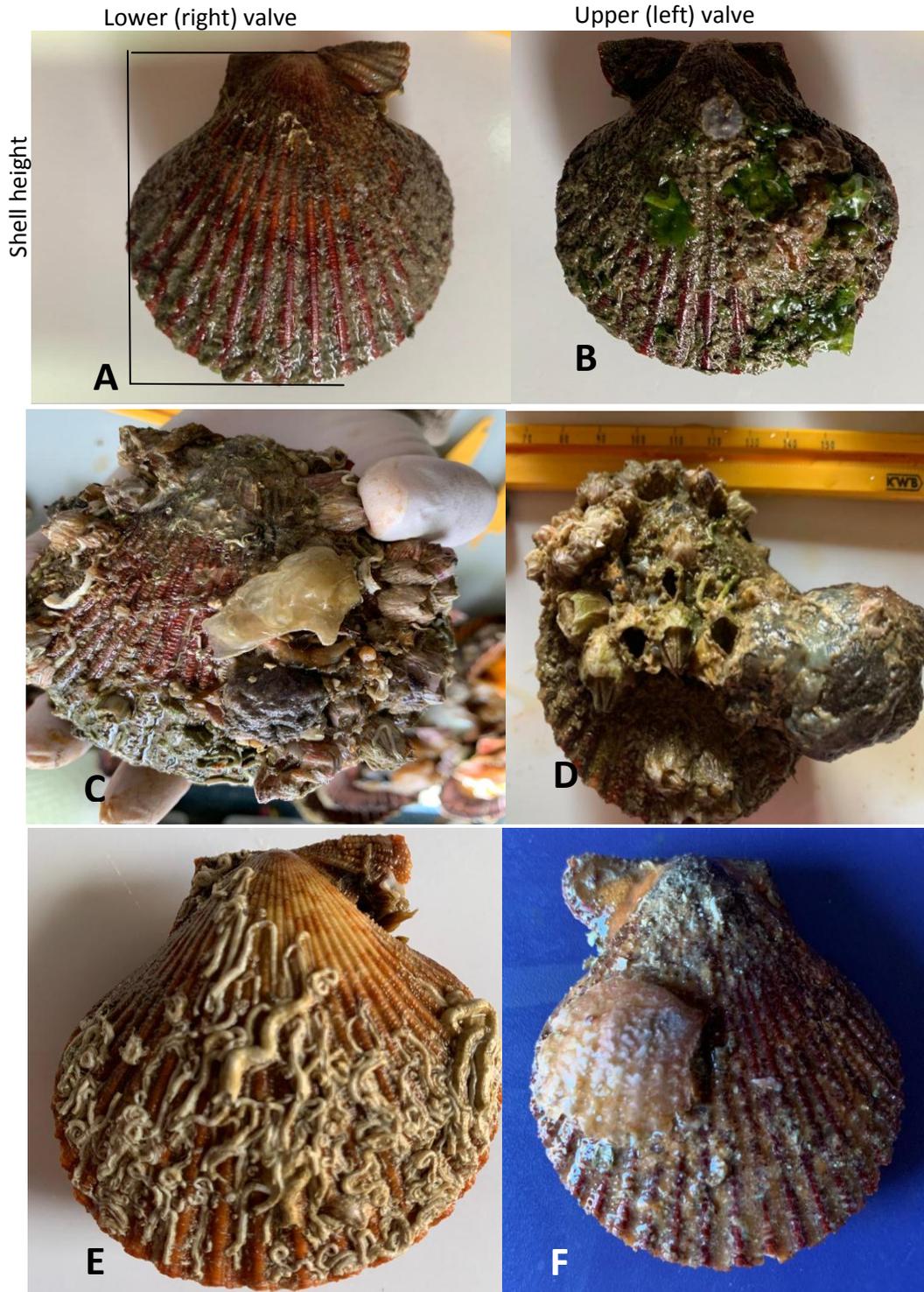


Fig. 3. **A-** *Mimachlamys sanguinea* covered with epibionts, **B-** Green algae and a spat of barnacles on the left (upper) valve, **C-** Heavy encrustation by bivalves and other epibionts, **D-** Dead and alive individual barnacles, **E-** Serpulids, and **F-** Spat of bivalve attached to the shell

Table 1. Different epibionts covering the shell of the scallop *Mimachlamys sanguinea* from the Suez Canal expansion channel

Epibiotic category	Species
Algae	<i>Enteromorpha prolifera</i> J. Agardh, 1883
Sponges	Demospongia
Hydrozoans	<i>Obelia geniculata</i> (Linnaeus, 1758)
Serpulids	<i>Hydroides elegans</i> (Haswell, 1883) <i>Hydroides dirampha</i> Mörch, 1863
Gastropods	<i>Patella ulyssiponensis</i> Gmelin, 1791 <i>Cellana rota</i> (Gmelin, 1971)
Bivalves	<i>Mimachlamys sanguinea</i> (Linnaeus, 1758). <i>Brachidontes pharaonis</i> (Fischer P., 1870) <i>Modiolus auriculatus</i> (Kraus, 1848) <i>Pinctada radiata</i> (Leach, 1814) <i>Pinctada margaritifera</i> (Linnaeus, 1758) <i>Vulsella vulsella</i> (Linnaeus, 1758)
Barnacles	<i>Balanus amphitrite</i> (Darwin, 1854) <i>Balanus eburneus</i> (Gould, 1841)
Bryozoans	<i>Bugula</i> sp.
Tunicates	<i>Ascidia cannelata</i> (Oken, 1820) <i>Phallusia nigra</i> (Savigny, 1816) <i>Styela canopus</i> (Savigny, 1816) <i>Styela plicata</i> (Lesueur, 1823) <i>Diplosoma listerianum</i> (Milne Edwards, 1841)

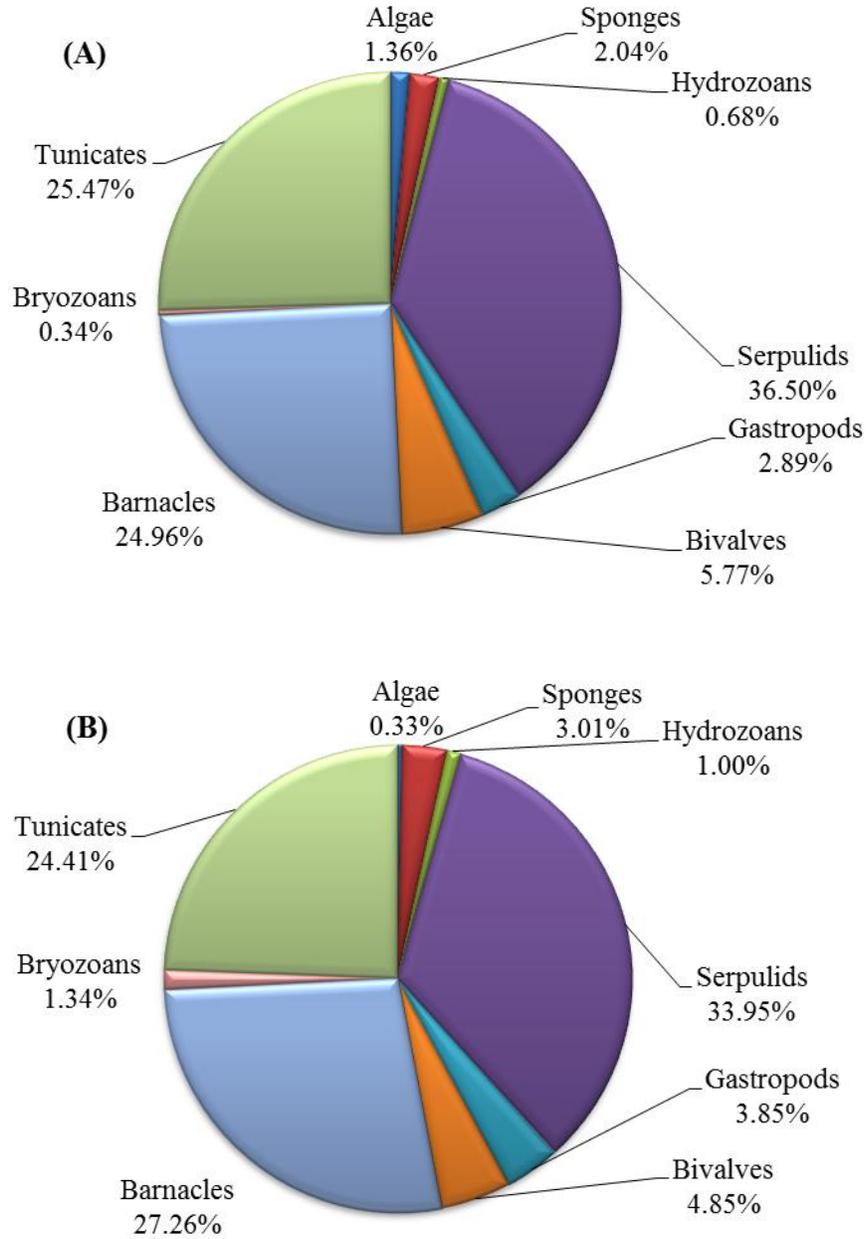


Fig. 4. Percentage of coverage of epibionts on the shell of *M. sanguinea* from the Suez Canal expansion channel showing: (A) Males and (B) Females

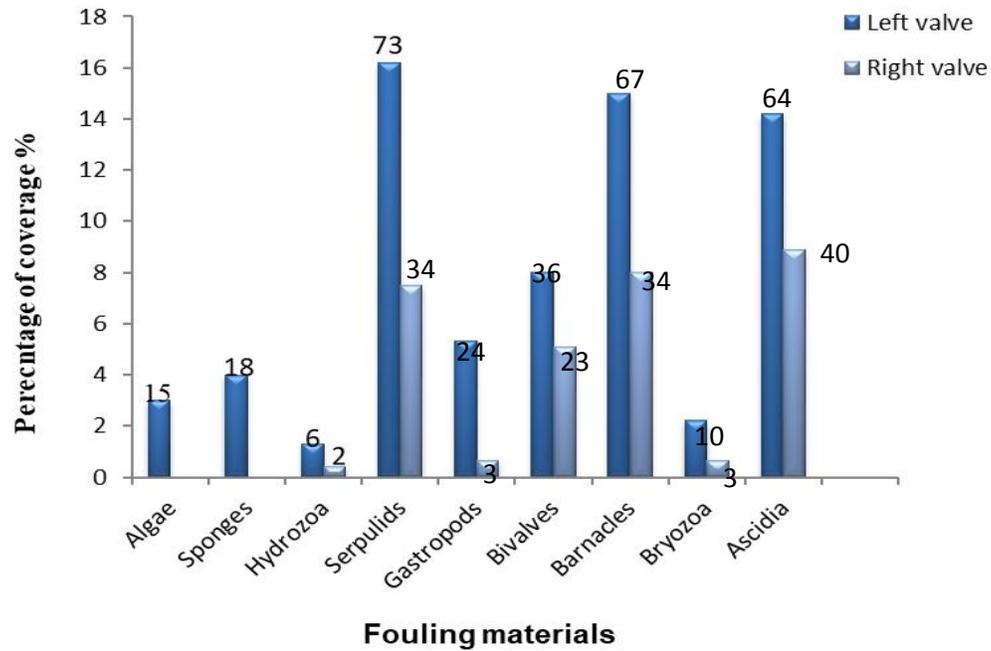


Fig. 5. Percentage of coverage of epibionts assemblage on *M. sanguinea* valves (Left and right). Number of individuals is given for each category

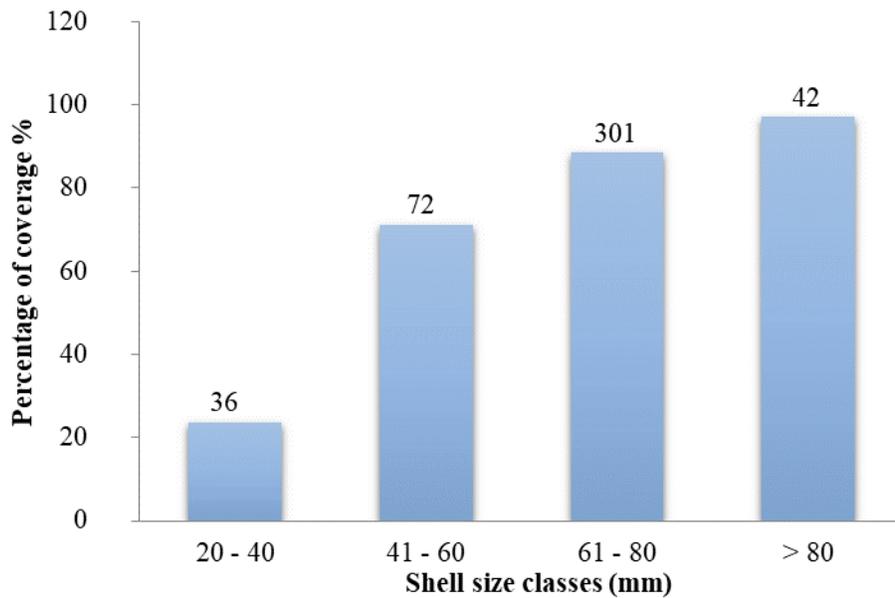


Fig. 6. Percentage of coverage of epibionts assemblage on *M. sanguinea* shells of different size classes (mm). Number of individuals is given for each

category

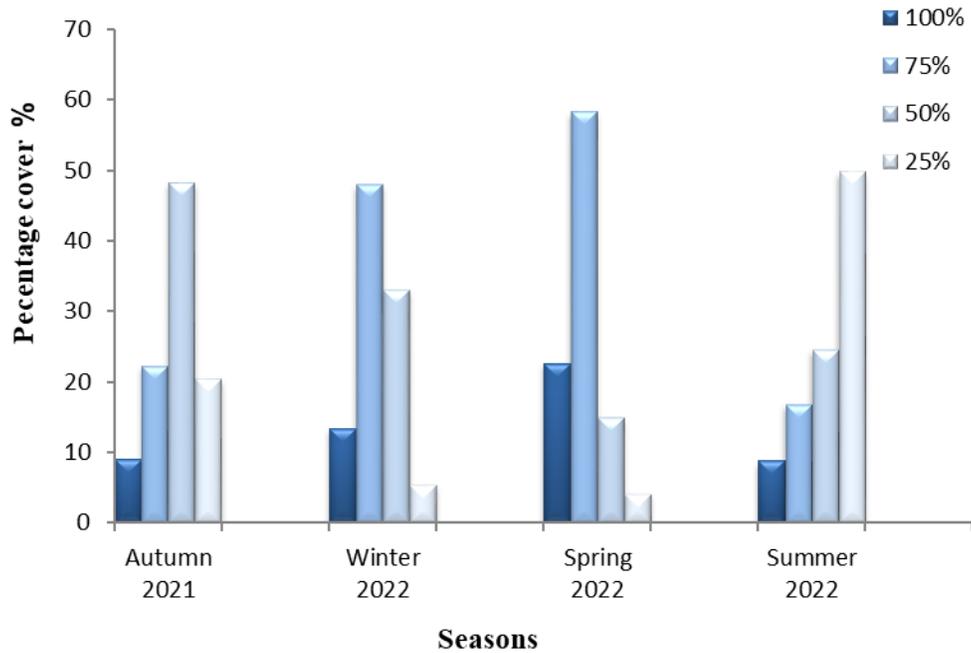


Fig. 7. Seasonal variations in the degree of percentage cover on the shell of *M. sanguinea* from the Suez Canal expansion channel

DISCUSSION

Observations made in this work confirmed the hypothesis that *M. sanguinea* acted as a suitable hard substratum for the settlement of epibionts in the study area. Epibiotic organisms accumulated excessively and passively on the bivalve shell as a result of the scarcity of hard substrates. The scallop shell is rough, sculptured by radial ribs which favor the accumulation of epibionts (Feifarek, 1987). Railkin (2004) reported that colonization in marine environment usually starts with the formation of a biofilm that attracts larger macrofoulers. However, bryozoans and barnacles do not need a biofilm (Ralston & Swain, 2009). Twenty-two taxa of sessile organisms were associated with *M. sanguinea* shells. Compared with studies on other pectinids around the world, *M. sanguinea* presented a relatively high number of epibionts (Souto *et al.*, 2012). For example, eighteen different epibiont taxa were associated with the scallop *Aequipecten tehuelchus* (d'Orbigny, 1846) in shelf waters off Argentina (Souto *et al.*, 2012).

Serpulids showed the highest percentage of coverage followed by barnacles and tunicates. This finding aligns with many studies around the world, for example, polychaetes were the most frequent epibiotic organisms on the scallop *Aequipecten*

tehuetchus in the shelf waters off Buenos Aires, Argentina (Souto *et al.*, 2012). Ward and Thorpe (1991) reported that barnacles and serpulids as the dominant encrusting epifauna of *Chlamys opercularis* from scallop beds off the Isle of Man. Barnacles, molluscs, and polychaetes were the most dominant fouling in the pearl oyster beds of the Qatari waters in Arabian Gulf (Al-Khayat & Al-Maslamani, 2001).

Sponges were a common epibiont on the exoskeleton of brachyuran crabs inhabiting the Suez Canal (Sallam & Wicksten, 2009), however they were scarce on the scallop shells. In this new area where sedimentation levels are high due to the continuous dredging operations, sponges are unlikely to be found. Notably, they are highly sensitive to suspended particles since their canals and chambers can be easily blocked by sediment (Gerrodette & Flechsig, 1979).

Although epibiosis can increase the shell of *Mimachlamys* weight which might limit its escape strategy, it could serve as a means of camouflage to achieve crypsis. The epibiont association on the scallop shell could be considered as a form of mutualism where it offers camouflage to scallops from predatory sea stars (Bloom, 1975; Vance, 1978; Feifarek, 1987). This colonization gives protection to the bivalve by avoiding adhesion of the tube feet of the sea star and forms a barrier around the shell openings to prevent it from inserting its digestive stomach (Pitcher & Butler, 1987). Cerrano *et al.* (2006) reported that the presence of barnacle covering negatively impacted the swimming of *Chlamys hastata* from the Antarctic waters which needed more energy than those without coverage. Scallop without heavily epibionts can swim longer distance (Donovan *et al.*, 2003).

Epibionts were found on shells of both sexes and of all sizes, which indicates that epibiosis starts even at the smallest stage of this scallop's size range. Moreover, young individuals of *M. sanguinea* were recorded among the epibionts living byssally attached to the adult shells. Cerrano *et al.* (2006) postulated that the scallops' larvae settle on any available hard substrata that they can find; nevertheless, the grazers feed on them. The authors concluded that the spats can only survive on the adult shells that avoid grazing by the clapping activity. The considerably large size of this bivalve in the study area might imply that *Mimachlamys* could be one of the first settlers in the new expansion channel subsequent to its opening. Being in a new environment with no predation pressure must have provided a good opportunity for this species to grow and flourish. The passive acquisition of the epibiotic cover could be considered as an advantage to the scallop in the event of potential occurrence of its predator. Scallops have been reported to have increased longevity. The lifespans of some scallops have been known to extend over six to seven years (Vause *et al.*, 2005).

In *M. sanguinea*, the left valve was more fouled than the right one. All epibiont categories were recorded on the right valve, except algae and sponges. Preference for any valve was noticed in some epibionts (Souto *et al.*, 2012). This phenomenon was observed

in many pectinid species and could be attributed to competitive relationships, different strategies of settlement developed by the different taxa, variations to the physical scratch effects and feeding habits (**Rosso & Sanfilippo, 1991; Ward & Thorpe, 1991; Schejter & Bremec, 2007**). It is worthy to mention that, pectinid scallops are unique in their ability to swim fast over few meters by frequently clapping their valves together. They can adjust themselves in a specific way resulting that scallops lie on the sediment on the right (lower) valve. Hence, the lower valve is less exposed to epifaunal larvae (**Bloom, 1975**).

The highest cover was observed in the largest shells (> 80mm). The larger the shell, the higher the percentage cover. The impact of shell size on the establishment of epibiont organisms has been studied by **Rosso and Sanfilippo (1991)**. They stated that the total surface encrusted tends to increase progressively from the small scallops to the large ones. Macrofaunal epibiont assemblages clearly increased on the large scallops, which were recessing into the sediment surface (**Berkman, 1994; Gutierrez et al., 2003**). Density of epifouling increased with shell surface area of the pearl oyster *Pinctada radiata* in the Qatari water (**Mohammed, 1998**).

Obvious seasonality in the degree of percentage cover of epibionts on the shell of *M. sanguinea* was recognized. Shells were mostly covered during spring and less covered during summer. This is contrary to the results of **Sallam and Wicksten (2009)**, who recorded winter as the season with the highest encrustation on the carapace of the spider crab *Hyastenus hilgendorfi* in the Suez Canal. On the other hand, summer is the season where the *Mimachlamys* recruits join the population. Differences in the occurrence of settled organisms are possibly related to the availability of associated organisms in the Suez Canal in the different seasons (**Sallam & Wicksten, 2009**).

This is the first study that provides information on the epibiont assemblages of scallop *M. sanguinea* inhabiting the Suez Canal expansion channel. More investigations are recommended to be carried out in order to understand the community structure and its relations with abiotic factors in this new environment. The study of epibiotic communities would be particularly of interest for explaining their relationship with the different hosts.

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REFERENCES

- Al-Khayat, J.A. and Al-Maslamani, I.A.** (2001). Fouling in the pearl oyster beds of the Qatari waters, Arabian Gulf. *Egypt. J. Aquat. Biol. Fish.* (4): 145 – 163. [Doi:10.21608/EJABF.2022.248811](https://doi.org/10.21608/EJABF.2022.248811)
- Berkman, P.A.** (1994). Epizoic zonation on growing scallop shells in McMurdo Sound Antarctica. *J. Exp. Mar. Biol. Ecol.*, 179: 49–67. [Doi:10.1016/j.jembe.2006.10.038](https://doi.org/10.1016/j.jembe.2006.10.038)
- Bloom, S.A.** (1975). The motile escape response of a sessile prey: a sponge-scallop mutualism. *J. Exp. Mar. Biol. Ecol.*, 17: 311-321. [Doi:10.1016/j.jembe.2006.10.038](https://doi.org/10.1016/j.jembe.2006.10.038)
- Burns, D.O. and Bingham, B.L.** (2002). Epibiotic sponges on the scallops *Chlamys hastata* and *Chlamys rubida*: increased survival in a high-sediment environment. *J. Mar. Biol. Assoc. UK.*, 82: 961-966. [Doi: 10.1017/S0025315422000480.](https://doi.org/10.1017/S0025315422000480)
- Cerrano, C.; Calcinai, B.; Bertolino, M.; Valisano, L. and Bavestrello, G.** (2006). Epibionts of the scallop *Adamussium colbecki* in the Ross Sea, Antarctica. *Chem. Ecol.*, 22: 235–244.
- Dijkstra, H.H. and Knudsen, J.** (1998). Some Pectinoidea (Mollusc: Bivalvia: Propeamussiidae, Pectinidae) of the Red Sea. *Mol. Res.*, 19: 43-104
- Donovan D.A.; Bingham B.L.; From M.; Fleisch A.F. and Loomis E.S.** (2003). Effects of barnacle encrustation on the swimming behaviour, energetics, morphometry, and drag coefficient of the scallop *Chlamys hastata* *J. Exp. Mar. Biol. Ecol.*, 83: 1-7. [Doi: 10.1017/S0025315422000480](https://doi.org/10.1017/S0025315422000480)
- Emara A.M. and Belal A.A.** (2004). Marine fouling in Suez Canal. *Egyptian J. Aquat. Res.*, 30: 189-206. [Doi: org/10.1016/j.ejar.2012.12.008](https://doi.org/10.1016/j.ejar.2012.12.008)
- Feifarek B. P.** (1987). Spines and epibionts as antipredator defenses in the thorny oyster *Spondylus americanus* Hermann. *J. Exp. Mar. Biol. Ecol.*, 105: 39-56. [Doi:10.1016/j.jembe.2006.10.038.](https://doi.org/10.1016/j.jembe.2006.10.038)
- Ibrahim N.K.** (2012). Epibiont communities of the two spider crabs *Schizophrys aspera* (H. Milne Edwards, 1834) and *Hyastenus hilgendorfi* (De Man, 1887) in Great Bitter Lakes, Suez Canal, Egypt. *Egyptian J. Aquat. Biol. Fish.*, 16: 133 – 144. [Doi:10.21608/EJABF.2022.248811](https://doi.org/10.21608/EJABF.2022.248811)
- Gerrodette T. and Flechsig A.O.** (1979). Sediment-induced reduction in the pumping rate of the tropical sponge *Verongia lacunosa*. *Mar. Biol.*, 55: 103-110.
- Gutierrez, J.; Jones, C.; Strayer, D. and Iribarne, O.** (2003). Mollusks as ecosystem engineers: the role of shell production in aquatic habitats. *Oikos*, 101: 79–90. [Doi:10.1111/oik.09171](https://doi.org/10.1111/oik.09171)
- Madkour, F.F.; Aamer, M.A. and El-Sherbiny, M.M.** (2006). Assessment of eutrophication in Lake Timsah, Suez Canal, Egypt. *Egyptian J. Aquat. Res.*, 32: 259-272.
- Millar, R. H.** (1970). British ascidians. Tunicata: Ascidiacea, keys and notes for the identification of the species. *Synopses of the British Fauna*. Academic Press: London and New York, pp. 88.

- Mohammed, S.Z.** (1998). On the epifouling of pearl oyster (*Pinctada radiata*) in Qatari water Arabian Gulf and its influence on the flesh growth. Egyptian J. Aquat. Biol. Fish., 2: 73 – 85. [Doi: 10.21608/EJABF.2022.248811](https://doi.org/10.21608/EJABF.2022.248811)
- Por, F. D.** (1978). Lessepsian migration. The influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Ecological Studies. Springer: Verlag, Berlin and Heidelberg. 228 pp.
- Por, F. D. and Lerner-Seggev, R.** (1966). Preliminary data about the benthic fauna of the Gulf of Elat (Aqaba), Red Sea. Israeli J. Zool., 15: 38-50.
- Pitcher, C.R. and Butler, A.J.** (1987). Predation by asteroids, escape response, and morphometrics of scallops with epizoic sponges J. Exp. Mar. Biol. Ecol., 112: 233–249. [Doi:10.1016/j.jembe.2006.10.038](https://doi.org/10.1016/j.jembe.2006.10.038).
- Rabaoui, L; Tlig-Zouari, S.; Cosentino, A. and Ben Hassine, O.K.** (2009). Associated fauna of the fan shell *Pinna nobilis* (Mollusca: Bivalvia) in the northern and eastern Tunisian coasts. Sci. Mar., 73: 129–141.
- Railkin, A. I.** (2004). Marine biofouling colonization processes and defenses. Boca Raton, FL: CRC Press.
- Ralston, E. and Swain, G.** (2009). Bioinspiration: the solution for biofouling control. Bioinspiration. Biomimicry 4, 015007. [Doi:10.1088/1748-3182/4/1/015007](https://doi.org/10.1088/1748-3182/4/1/015007).
- Rosso, A. and Sanfilippo, R.** (1991). Epibionts distribution pattern of *Chlamys patagonica* (King and Broderip) of the Magellan Strait. Memorie Biol. Mar. Ocean., 19: 237–240.
- Sallam, W.S. and Wicksten, M.K.** (2009). *Hyastenus hilgendorfi* (De Man, 1887) (Brachyura, Pisidae): A heavily encrusted decorator crab inhabiting the Suez Canal. *Crustaceana*, 84: 203-219.
- Schejter, L. and Bremec, C.** (2007). Epibionts on *Flexopecten felipponei* (Dall, 1922), an uncommon scallop from Argentina. American Malacol. Bull., 22: 75–82.
- Sharabati, D.** (1984). Red Sea Shells. KPI Ltd., London, Boston, Melbourne, Henley. 127 pp.
- Shefer, S.; Feldstein, T.; Mienis, H.K.; Rittner, Oz. and Gur, A.** (2012). First record of *Mimachlamys sanguinea* (Linnaeus, 1758) from the Mediterranean coast of Israel (Bivalvia, Pectinidae). *Triton*, J. Israel Malacol. Soc. 25.
- Sokal, R. and Rohlf. F.** (1979). Biometry. The Principles and Practice of Statistics in Biological Research. Peter Marshall: United States of America. 12 pp.
- Soliman, Y.S. and Yassien, M.H.** (2007). Impact of marine fouling organisms relevant to the water conditions on the cooling systems of power stations. I- Attaqa power station, Suez Bay. Egyptian J. Aquat. Biol. Fish., 11 (3): 1085-1099.
- Souto, V.S.; Schejter, L. and Bremec, C.S.** (2012). Epibionts on *Aequipecten tehuelchus* (d'Orbigny, 1846) (Pectinidae) in shelf waters off Buenos Aires, Argentina. American Malacol. Bull. 30: 261–266.

- Suez Canal Authority**, (2022). <https://www.suezcanal.gov.eg>
- Tarjan, A. C.** (1980). Illustrated guide to the marine nematodes. IFAS: University of Florida, Gainesville, 135 pp.
- Vance, R.R.** (1978). A mutualistic interaction between a sessile marine clam and its epibionts. *Ecology*, 59: 679–685.
- Vause, B. J., Beukers-Stewart and Brand, A.** (2005). Age composition and growth rates of queen scallops *Aequipecten opercularis* (L.) around the Isle of Man. *J. Shellfish Res.*, 25: 310-312.
- Wahl, M.** (1989). Marine epibiosis. 1. Fouling and antifouling: some basic aspects. *Mar. Ecol. Pro. Series*, 58: 175–189.
- Wahl, M.** (2009). *Marine Hard Bottom Communities*, Ecological Studies 206, Springer Verlag, Berlin and Heidelberg. [DOI: 10.1007/978-3-540-92704-4_4](https://doi.org/10.1007/978-3-540-92704-4_4).
- Ward, M.A. and Thorpe, J.P.** (1991). Distribution of encrusting bryozoans and other epifauna on the subtidal bivalve *Chlamys opercularis*. *Mar. Biol.*, 110: 253-259.
- Zar, J. H.** (1984). *Biostatistical analysis*. 4th Edition, Prentice Hall, Upper Saddle River. 929 pp.